2100 #5 BT 7-24-02

PATENT
#01-0266-UNI
Case #F3277(C)

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to:

"Assistant Commissioner for Patents
Washington, D.C. 20231"

on July 11, 2002

EDWARD A. SQUILLANTE, JR.
Reg. No. 38,319
Attorney for Applicant(s)

07/11/02
Date of Signature

OIPE JC10 JUL 15 2002 PATENT & TRADEMARK OFFICE

RECEIVED
JUL 22 2002
TC 1700

RECEIVED
JUL 23 2002

RECEIVED
JUL 19 2002
Technology Center 2600

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Blair et al.
Serial No.:	10/090,979
Filed:	March 5, 2002
For:	BLACK TEA MANUFACTURE

Edgewater, New Jersey 07020
July 11, 2002

SUBMISSION OF PRIORITY DOCUMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Pursuant to rule 55(b) of the Rules of Practice in Patent Cases, Applicant(s) is/are submitting herewith a certified copy of the United Kingdom Application No. 0105374.3 filed March 5, 2001; and United Kingdom Application No. 0125765.8 filed October 26, 2001, upon which the claim for priority under 35 U.S.C. § 119 was made in the United States.

It is respectfully requested that the priority document be made part of the file history.

Respectfully submitted,

Edward A. Squillante, Jr.
Reg. No. 38,319
Attorney for Applicant(s)

EAS/mt
(201) 840-2925

The Patent Office

OIPE JC10 JUL 15 2002 PATENT & TRADEMARK OFFICE

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

RECEIVED
JUL 22 2002
TC 1700

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed R. Mahoney

Dated 19 December 2001

Patents Form 1/77 05 MAR 2001
LONDON

Patents Act 1977
(Rule 16)

The Patent Office

06MAR01 E611019-1 D02898
P01/7700 0.00-0105374.3

The Patent Office

Cardiff Road
Newport
Gwent NP10 8QQ

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

05 MAR 2001

1. Your reference — **F3277(C)/ijh**

2. Patent application number *(The Patent Office will fill in this part)* — **0105374.3**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

UNILEVER PLC
UNILEVER HOUSE, BLACKFRIARS
LONDON, EC4P 4BQ

Patents ADP number *(if you know it)* — 1628002

If the applicant is a corporate body, give the country/state of its incorporation — **UNITED KINGDOM**

4. Title of the invention — **BLACK TEA MANUFACTURE**

5. Name of your agent *(if you have one)* — **EVANS, Jacqueline Gail Victoria**

"Address for Service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

PATENT DEPARTMENT, UNILEVER PLC
COLWORTH HOUSE, SHARNBROOK
BEDFORD, MK44 1LQ

Patents ADP number *(if you know it)* — ~~1628003~~ 8094518001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day/month/year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	25
Claim(s)	2
Abstract	1
Drawing(s)	10 +10 8W

10. If you are also filing any of the following, state how may against each item.

Priority Documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Date: **05/03/01**

Sandra EDWARDS, Authorised Signatory

12. Name and daytime telephone number of person to contact in the United Kingdom **Isobel Howell, Tel 01234 22 2216**

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*
b) *Write your answers in capital letters using black ink or you may type them.*
c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*
d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*
e) *Once you have filled in the form you must remember to sign and date it.*
f) *For details of the fee and ways to pay please contact the Patent Office.*

BLACK TEA MANUFACTURE

The present invention relates to tea processing, or more specifically, a process for manufacturing a high quality larger leaf black tea.

Background and prior art

Leaf tea may be prepared as green leaf tea or black leaf tea. Generally, to prepare black leaf tea fresh green leaves of the plant *Camellia sinensis* are withered (subjected to mild drying), comminuted, fermented (in which process enzymes in the tea leaf use atmospheric oxygen to oxidise various substrates to produce brown-coloured products) and then fired (to dry the tea leaves). Green leaf tea is not exposed to the fermentation process. Partial fermentation may be used to produce intermediate-type teas known as "oolong" tea.

Conventional wisdom dictates that in black tea manufacture tea must be macerated in some way to liberate the fermentative enzymes and their substrates within the leaves. One can macerate tea in many ways but broadly speaking there are two main mechanised methods for doing this.

The first, called "orthodox manufacture", involves rolling pre-weighed batches of heavily withered tea leaves prior to fermenting, firing and drying steps. So called "orthodox tea" is typically characterised by leaf particles that are aesthetically pleasing to many (resemble dried leaves rather than "granules" of CTC tea - see below) but produce lighter liquors due to less extensive fermentation and poorer infusion from the larger particles.

The second method is the most popular of a number of non-orthodox, continuous methods that involves using a machine resembling a mangle that cuts, tears and curls tea leaves. The original machine was invented by W. McKercher in 1930 and is commonly referred to as a CTC (cut-tear-curl) machine. The finely cut product is known generically as "CTC tea" and is characterised by a fast infusion rate and strong colour. This method tends to produce tea that is more consistent and uniform in quality and than the orthodox method, but with an appearance of "granules" rather than leaf fragments.

Both orthodox and CTC rollers are often used in conjunction with a rotorvane machine, which is a type of extruder used to pre-condition (squeeze/shred) leaves prior to maceration. The rotorvane was invented as a form of continuous orthodox roller, but is rarely used as such today. Liquors generated from rotorvane teas are similar to orthodox in terms of liquor properties and infusion rates. These methods and their history and role in tea manufacture are described in "Tea: Cultivation to Consumption" edited by K. C. Willson and M. N. Clifford, Chapman & Hall, 1992.

Generally speaking consumer preference for either orthodox or CTC tea is a matter of national or regional culture. In many countries the visual appearance and texture of leaf tea are important indicators of quality, larger leaf particles being associated with higher quality. In Western markets tea is increasingly purchased in filter paper bags and the colour of the infused product tends to be more important.

Some consumers however want the best of both worlds; i.e. a leaf tea that looks and feels like orthodox processed tea but has the liquor characteristics of a fuller fermented CTC processed tea. There is no commercially available tea manufacturing equipment that can deliver such a leaf tea.

The present applicants have developed methods for manufacturing black leaf teas that resemble orthodox processed tea but infuse like CTC processed tea.

For example our international patent application WO 99/40799 discloses another method that involves subjecting whole tea leaves to a heat shock at a temperature and for a duration that is sufficient to initiate fermentation, and enabling the tea to ferment for a time and at a temperature that is sufficient to achieve desired liquor properties.

Our international patent application WO 00/10401 discloses yet another method for manufacturing fast infusing whole or large leaf teas whereby whole leaf tea is impregnated tea leaves with liquid carbon dioxide within a pressure vessel, depressurising the vessel at a rate that is sufficient to freeze the liquid carbon dioxide, applying sufficient heat to cause the frozen carbon dioxide to sublime and consequently initiate fermentation within the leaves, allowing the tea to ferment for a time that is sufficient to achieve desired liquor properties, and drying the fermented product to yield the whole leaf tea.

More recently our co-pending United Kingdom patent application GB 0010315.0 discloses a method that involves withering a first supply of freshly plucked tea leaves, macerating the withered leaves, allowing the macerated withered leaves to ferment to produce macerated dhool, withering a second supply of freshly plucked tea leaves, mixing the macerated dhool obtained from the first supply of leaves with the withered leaves obtained from the second supply of leaves, rolling the mixture, allowing the rolled mixture to ferment, and drying the fermented mixture to yield black leaf tea.

The present inventors, through a deeper understanding of the fermentation and infusion processes of tea, have developed an alternative method for making fast-infusing large and medium leaf

black tea. This method can utilise adapted tea manufacturing equipment (such as the rotorvane and CTC) or novel processing equipment, but requires a thorough understanding and control of raw material (green leaf) properties, and the interaction with the processing equipment.

The advantages of the new method include the capability to manufacture leaf with orthodox appearance and CTC infusion characteristics, but with less process complexity than the method described in GB 0010315.0, with greater flavour (and therefore higher quality as judged by international tea tasters) and with more flexibility to alter leaf shape and/or size (the latter being important especially when the product is to be packed in to tea-bags).

The present inventors have found that large tea leaves can be difficult to dose when making tea bags. While one could simply remove the largest leaves using a sieving system and perhaps recycle them in the process it is clearly preferable to be able to manufacture the desired product with the maximal yield and quality. The inventors therefore developed an alternative method for making fast infusing large and medium size black leaf tea.

Statement of the invention

In broad terms the present invention relates to a process for manufacturing black tea comprising the steps of withering and macerating tea leaves, allowing them to ferment, firing the leaves to arrest fermentation and then drying them to yield black leaf tea, the process being characterised in that the tea leaves are withered to a moisture content of between 64 and 68% and macerated by the controlled application of both shear and compression forces.

Black leaf tea made in this way resembles orthodox processed leaf tea but infuses in freshly boiled water at a rate in excess of that of the equivalent mass of the same size grade tea that has undergone orthodox processing. The quality of the infusion is especially high.

In one example, using adapted commercial tea manufacturing equipment, freshly plucked tea leaves are withered to a target moisture content between 64 and 68%, passed through a high pressure rotorvane machine modified to deliver increased shear and compression, followed by a singlet CTC machine to further tailor the size and shape of the particles. The blade of the CTC machine preferably has 2 to 6 teeth per inch rather than the conventional 8 to 10 teeth per inch. This enables the CTC machine to reduce the size of very long leaves and stalk without producing the finely cut leaf pieces that typify conventional CTC processed tea.

The withered leaves are preferably subjected to said controlled shear by being passed through a rotorvane with reverse facing vanes, or similar equipment capable of delivering the required forces, and subsequently further cut with the 6 tpi CTC or a dicing \ chopping capable of delivering the required size and shape profile.

"Tea" for the purposes of the present invention means leaf material from *Camellia sinensis* or *Camellia assamica*. It also includes rooibos tea obtained from *Aspalathus linearis* however that is a poor source of endogenous fermenting enzymes. "Tea" is also intended to include the product of blending two or more of any of these teas.

"Leaf tea" means tea that contains one or more tea origins in an uninfused form.

"Black leaf tea" means substantially fermented leaf tea.

For the avoidance of doubt the word 'comprises' is intended to mean including but not necessarily "consisting of" or "composed of". In other words the listed steps or options need not be exhaustive.

Detailed description of the invention

The process of the present invention combines steps normally associated with CTC manufacture with those normally associated with orthodox manufacture and/or those normally associated with non-tea related food processing in a way that provides high quality large leaf tea within a predetermined grade profile.

In the process a supply of freshly plucked tea leaves (so called green leaf) is withered prior to being macerated. The leaves can be withered in any conventional manner, for example by storing them for a period of time, usually perhaps up to 16 to 24 hours, during which time they undergo various biochemical and physical changes and typically lose moisture. The leaves must be withered to have a specific leaf moisture content between 64 and 68%. This degree of wither is less than that used in conventional orthodox tea manufacture (where final moisture content is usually less than 60%, often near 50%). It is also more than that used in conventional CTC tea manufacture, where the degree of wither has to be greater than 68% (final moisture content usually near 70 - 72%) otherwise too much heat is generated in the CTC machinery, especially at commercial throughputs. This controlled withering is important not only for flavour generation (as conventionally accepted) but also to alter the physical properties of the leaf to optimise their interaction with the maceration equipment, and enable the necessary commercial throughputs.

The withered leaf is then subjected to a controlled shearing and squeezing action by some suitable means. The present inventors

have found that subjecting the leaf to specific forces during maceration (compressing and squeezing the leaf) results in effective internal disruption (required for the initiation of fermentation) and also juice expression (leading to enhanced fermentation in the larger particles, as oxygen limitations may be overcome, and enhanced infusion rates and potentially soluble components are liberated from inside the particles and coated on the exterior surfaces) a combination of which leads to a particularly high quality leaf tea product.

This shearing and squeezing action can be achieved using a high pressure rotorvane machine with reverse facing vanes, or similar equipment capable of delivering the required forces (e.g. various extruder designs are possible). This step can be followed by a singlet CTC machine to further tailor the size and shape of the particles. The blade of the CTC machine preferably has 2 to 6 teeth per inch rather than the conventional 8 to 10 teeth per inch. This enables the CTC machine to reduce the size of very long leaves and stalk without producing the finely cut leaf pieces that typify conventional CTC processed tea. Alternatively a dicing or chopping machine capable of delivering the required size and/or shape profile can be employed.

The present inventors have found that dicing machines, particularly food dicing machines such as the J9-A model two dimensional belt-fed dicer with circular knives and the COMMITROL™ food processors with rotary micro-cut heads that are commercially available from Urschel Laboratories Incorporated, Valparaiso, Indiana, USA are particularly suitable for this purpose.

The macerated leaves are then left to ferment. The term "fermentation" is commonly used in the context of brewing alcohol to describe the action of exogenous enzymes. However in the tea world it is used to refer to the oxidative process that tea undergoes when certain endogenous enzymes and substrates are brought together following the disruption of the cell walls and

tissues. During this process colourless catechins in the leaves are converted to a complex mixture of yellow and orange to dark-brown substances and a large number of aromatic volatile compounds are also produced. Fermentation can carried out in a tub fermenter if desired.

The present inventors have found that the macerated leaf should be left to ferment for at least more than one hour, preferably more than two hours but preferably not more than 3 hours. A fermentation time of about 140 minutes is especially preferred. Leaving the leaves to ferment for longer than three hours can detrimentally effect the quality of the final product. It can also have cost implications. These times are dependant on the ambient temperatures, but are comparable to conventional times for fermentation of CTC tea.

Fermentation is preferably conducted at ambient temperature, i.e. about 25 °C, although 18 °C or even 15 °C can be suitable. If desired, fermentation can be accelerated at slightly higher temperatures such as 30 °C. The use of an oxygen-enriched atmosphere in a fermentation vessel is also beneficial.

The mass of fermented leaf macerate is known as known as dhool.

If desired, one can initiate fermentation in the withered leaves by subjecting the leaves to a heat shock at a temperature and for a duration that is sufficient to initiate fermentation as described in our international patent application WO 99/40799. Alternatively, one could impregnate the withered tea leaves with liquid carbon dioxide within a pressure vessel, depressurise the vessel at a rate that is sufficient to freeze the liquid carbon dioxide, apply sufficient heat to cause the frozen carbon dioxide to sublime and consequently initiate fermentation within the leaves, allow the tea to ferment for a time that is sufficient to achieve desired liquor properties, and dry the fermented product to yield the whole leaf tea. Such a method is described in our

international patent application WO 00/10401. A further alternative method of disrupting the leaves and initiating fermentation of rolled leaves is to subject the leaves to cycles of freezing and thawing.

If desired, the dhool can be treated with tannase (flavanol gallate esterase) to generate degallated catechins and gallic acid (which subsequently leads to the generation of high levels of theaflavins and non-gallated thearubigins during fermentation) or treated with tannase followed by hydrogen peroxide in a quantity that is sufficient for the endogenous peroxidases to oxidise gallic acid liberated by the tannase treatment. These treatments generate coloured species and enhance flavour. They are described in detail in our international patent application WO 00/47057, the disclosure of which is incorporated herein by reference.

The fermented dhool can be sifted to remove any remaining long leaves or stalk fragments.

As a final step, the fermented mixture is fired and dried to yield a black leaf tea that resembles orthodox processed leaf tea but infuses in freshly boiled water at a rate in excess of that of the equivalent mass of the same tea that has undergone orthodox processing.

The firing involves heating and drying the tea to destroy the fermenting enzymes and thereby arrest fermentation. It results in a reduction of moisture content to below 5%, and also leads to further chemical/biochemical oxidation and changes in tea aroma. This generally involves exposing the tea to a blast of hot, dry air in a dryer, for example a fluid bed dryer.

The present inventors, and expert tea tasters, were very surprised at the quality of the product produced by the process of the invention. Not only does it have the appearance of orthodox leaf, and the fast infusion and red liquors associated with CTC teas,

but it also has a very high overall quality and flavour. This has resulted from a biochemical and processing understanding being exploited to develop a new process to effectively deliver the most useful attributes from both CTC and orthodox teas, in one product.

Orthodox appearance

An expert tea taster can clearly distinguish teas that have the appearance of orthodox and teas that have the appearance of CTC processed tea. In layman's terms, orthodox tea tends to be flattened, rolled and twisted and CTC processed tea is more granular in appearance. While tea tasting (which includes grading) can appear to be more of an art than a science, the skilful precision with which experienced tea tasters can judge and categorise teas should not be underestimated.

In Example 1 an expert tea taster assessed black leaf tea made by the process of the present invention as being orthodox tea.

Orthodox appearance as determined by particle shape

The flattening, rolling and twisting operations that typify orthodox black tea manufacture tend to produce slivers of leaf fragments whereas the more disruptive chopping action of CTC machines produces granular tea fragments that are more uniform in size and shape. One can therefore characterise teas that have an orthodox appearance as having an average length that is preferably at least twice the average width of the tea (i.e. an aspect ratio of 2:1), more preferably at least three times the average width of the tea (i.e. aspect ratio 3:1).

In an extension to this, as an attempt to define orthodox appearance the applicant has devised a method for effectively measuring the roundness of tea fragments, or rather their

deviation from perfect roundness (see Example 2). The method involves making images of tea fragments and measuring the D-circle perimeter ratio (DCPR). The DCPR is defined by the expression:

$$DCPR = \frac{P}{2.\sqrt{(A.\pi)}}$$

wherein P is the observed perimeter of a particle and A is its observed area. It is in effect the ratio between the actual perimeter of an object and the perimeter of its D-circle - i.e. a hypothetical circle that has the same area as the object. This parameter has a minimum value of DCPR = 1 (for a circle). All other shapes have DCPR values greater than one. It is independent of size.

The aspect ratio versus DCPR based on perfect rectangles can be compared as follows: 1:1 (1.128), 2:2 (1.197), 3:1 (1.303), 4:1 (1.410), 5:1 (1.514), 6:1 (1.612), 7:1 (1.706), 8:1 (1.795), 9:1 (1.881) and 10:1 (1.962). Of course in practice the irregular edges of real tea particles would increase the DCPR slightly. A black leaf tea of the present invention is one where preferably at least about 5% of the tea particles have a D-circle perimeter ratio of 1.6 or greater, more preferably at least about 10% of the tea particles have a D-circle perimeter ratio of 1.6 or greater, and even more preferably at least about 15% of the tea particles have a D-circle perimeter ratio of 1.6 or greater. This corresponds to an aspect ratio, for the relevant percentages, approaching 6:1.

Modification of appearance by cutting after rotorvane

DCPR analysis was also performed on novel large leaf manufactured using the process described in co-pending United Kingdom patent application GB 0010315.0, together with products manufactured

using the high pressure rotorvane as described above, with and without a subsequent 6 tpi CTC cut.
Quartile analysis reveals that exposing the leaves to higher pressure during maceration (as in the high pressure rotorvane) can lead to a higher percentage of longer leaf particles, particularly in the large size fractions. Whilst this may be advantageous in some instances production of more uniform particles is necessary for many uses, particularly packing in to tea bags. It can be seen that treatment of the leaf with a cutting step (such as the 6 tpi CTC) post-rotorvane can modify the appearance in a positive manner. The product still resembles orthodox leaf, but is now more uniform in shape (i.e. "squarer"). Yield of "tea-bag compatible" grades increases from about 35 to 40% without the 6 tpi CTC machine to 55 to 60% with it.

CTC infusion character as determined by infusion performance

Black leaf tea made by the process of the present invention resembles orthodox processed black tea, at least on a macroscopic level, but it does not exhibit the infusion characteristics of orthodox processed tea. The product of the process of the present invention exhibits infusion characterises normally only in seen in CTC processed teas. These characteristics include the rate and extent of infusion as evidenced by the amount of colour generated within a fixed time.

Infusion performance is determined in part by leaf particle size. Small leaves or leaf portions have a larger surface to volume ratio than large leaves or leaf portions and thus will tend to infuse faster than large leaves. The applicant has shown in Example 3 that when using comparable leaf sizes infusions of orthodox teas tend to be less red and more yellow than infusions of CTC teas and teas made by the process of the of the present invention infuse more like a CTC leaf tea than an orthodox leaf tea.

Ideally the black leaf tea of the present invention preferably infuses at a rate that is at least as fast as the equivalent mass of the same tea or one of a comparable size that has undergone CTC processing. The black leaf tea can be blended with traditionally processed black tea or tea granules in order to meet predetermined liquor characteristics.

The infusion kinetics of the tea of the present invention have been compared to those of the United Kingdom patent application GB 0010315.0, and it can be clearly seen that for the two grades shown (large and medium leaf), the present leaf infuses faster and delivers a darker liquor. The co-pending application describes a process manufacturing orthodox leaf with CTC infusion, that depends on the "co-extrusion" (e.g. in a rotorvane) of freshly withered leaf and fermented CTC dhool. The present invention delivers a product with similar or improved infusion characteristics from a logistically less complex process (i.e. not requiring separate process lines for CTC dhool and leaf).

CTC infusion character as determined by liquor quality

CTC infusion character can be determined by an expert tea taster, both in the presence or absence of milk, both qualitatively and quantitatively on a suitable industry scale. Tea experts can rate liquor quality (i.e. measuring taste attributes including flavour volatiles), colour, brightness and thickness using a scale such as that used in Examples 4 and 5.

The black leaf teas of the present invention infused in the absence of milk (as is common in Continental Europe and USA) or with milk added (as is common in the United Kingdom) provide a liquor quality that resembles that of CTC manufactured teas rather than orthodox manufactured teas. The distinction was found to be more sharp when assessing the milked infusions. In fact the milked infusions of the black leaf teas of the present invention

have been found to be as well coloured as the more colourful CTC infusions.

One might even define the black teas of the present invention as those which when infused in tap water (Crawley, United Kingdom) for 2 minutes and 15 seconds at a concentration of 13.3 g/l then milked by adding 10 ml milk per 235 ml infusion the liquor quality is between from 4 to 6, but preferably between from 5 to 6.

The sensory properties of the tea of the present invention have been compared to those of the United Kingdom patent application GB 0010315.0, through Sensory Analysis (QDA). This reveals significant differences in the aroma's of the two products, with higher aroma scores given for the tea of the current invention (contributing to the high quality as judged by the expert tea tasters).

The black leaf tea that is manufactured by the process of the present invention can be blended with traditionally processed black tea or tea granules in order to meet predetermined liquor characteristics.

The process of the invention will now be described with reference to the following illustrative examples.

EXAMPLE 1

Differentiating between the appearance of orthodox and CTC teas using an expert tea taster

The inventors asked an expert tea taster to select 17 teas from around the world, some orthodox and some CTC. They then asked the expert to classify those teas as well as two grades of each of XXX black leaf teas that were made by the method of the present invention as being either orthodox or CTC teas. The results are given in Table 1 below.

TABLE 1

Comparison of known and novel teas by an expert tea taster

Code	Type	Origin	Size	Leaf
ODX1	Orthodox	Indonesia	BOPF	OT5
ODX2	Orthodox	China	BOP	OT3
ODX3	Orthodox	Assam	FBOP	OU5
ODX4	Orthodox	Ceylon	EBOP	OU8
ODX5	Orthodox	Ceylon	BOP	OT5
ODX6	Orthodox	Indonesia	BOP	OT6
ODX7	Orthodox	Ceylon	BOP	OT5
CTC1	CTC	Siongo	BP1	CH6
CTC2	CTC	Ecuador	BP1	CH3
CTC3	CTC	Kavuzi	BP1	CH4
CTC4	CTC	Indonesia	BP1	CH3
CTC5	CTC	Vietnam	BOP	CI3
CTC6	CTC	Malawi	BP1	CI4
CTC7	CTC	Kenya Rukuriri	BP1	CH7
CTC8	CTC	Kenya Bondet	BP1	CH4
CTC9	CTC	Ceylon	BP1	CH4
CTC10	CTC	Assam	BP	CH5
ML	-	Kenya, Kericho	ML	OV4
ML	-	Kenya, Kericho	ML	OV5
LL	-	Kenya, Kericho	LL	OT4
LL	-	Kenya, Kericho	LL	OT5
LL	-	Kenya, Kericho	LL	OT6

Wherein the first letter of the three-letter code denotes whether the leaf tea has the appearance of leaf tea made by orthodox manufacture (O), CTC manufacture (C), or a mixture (M).

The second letter denotes the leaf size in accordance with standard manufacturers' grades as described in Table 2 below:

TABLE 2
Leaf size classification

CTC leaf size	Manufacturers' grades	ORTH leaf size	Manufacturers' grades
A	D2/CD	O	CD/ D3
B	D1	P	D
C	D	Q	PD/ SF
D	PD	R	BOPF/ PF
E	SMALL FNGS/PF/ PF1	S	FNGS/ FNGS2
F	PF1	T	BOP/ LEAFY POBF/ BT
G	LEAFY FNGS/ SMALL BP	U	LEAFY BOP/ SMALL PEKOE/ FBOP
H	BP1/ BOP	V	PEKOE
I	BOLP BP	W	LARGE PEKOE/ BPS
J	BM	X	OP
K	BMF	Y	BP/ BP2
		Z	BT2/ BM

And the third letter denotes the leaf style in accordance with the rating system given in Table 3 below:

TABLE 3
Leaf style classification

Style	Leaf description
1	Powdery
2	Very stalky/fibrous
3	stalky/fibrous
4	Mixed/few fibres
5	Rather mixed
6	Fair
7	Good
8	Very good
9	Speciality/excellent style

The assessment is made on the basis of a number of factors including leaf size, twist, surface area and colour. In each case the tea taster classified the black teas of the invention as having an orthodox appearance.

EXAMPLE 2

D-circle perimeter ratio analysis

As mentioned above, the flattening, rolling and twisting operations that typify orthodox black tea manufacture tend to produce slivers of leaf fragments tea whereas the more disruptive chopping action of CTC machines produces granular tea fragments. The applicant has devised a method for effectively measuring the roundness of tea fragments, or rather their deviation from perfect roundness.

The method involves making images of tea fragments and measuring the D-circle perimeter ratio (DCPR). The DCPR is defined by the expression:

$$DCPR = \frac{P}{2.\sqrt{(A.\pi)}}$$

wherein P is the observed perimeter of a particle and A is its observed area. It is in effect the ratio between the actual perimeter of an object and the perimeter of its D-circle - i.e. a hypothetical circle that has the same area as the object.

This parameter has a minimum value of DCPR = 1 (for a circle). All other shapes have DCPR values greater than one. It is independent of size.

Tea samples were taken from the 21 "world teas" used in Example 1 and compared with samples of medium long leafed teas and long leafed teas prepared by the process described in our co-pending international patent application PCT/EP99/00775. In each case small samples were then taken randomly with a spatula.

Only the outline shape of the particles (i.e. silhouettes) of the particles needed to be imaged, not the surface detail. It was

also important that shadows be avoided. The leaf samples were therefore spread out on a sheet of glass and back-illuminated on a WILD M8™ low power microscope. A magnification was chosen which allowed as many particles as possible per field, but at the same time allowed each particle to be sufficiently large for meaningful measurements to be taken. The magnification chosen gave a field size of 21 x 15.75 mm.

Images were grabbed using a JVC KY 55™ camera and a NOETECH™ frame grabber. The pixel resolution was 768 x 576. Some background was left visible in each micrograph in order to ensure that the particles had not been eroded by over-lighting. Twelve or fifteen fields were taken for each sample, giving a total particle count of typically 300 - 400. All images were permanently archived.

An image analyser (KONTRON KS 300™) was used to measure binary images (i.e. where all pixels are either black of white). The areas to be measured are rendered white, the background is black. 'Segmentation' is the process by which the binary image is generated from the original.

The original image was rendered monochrome. A threshold level was selected below which everything was rendered black (pixel value = 0) and above which everything was rendered white (i.e. pixel value = 255). The threshold level varied slightly from image to image, and was chosen to avoid either dilating or eroding the outline of the particles; it was generally around 140. This produced an image in which the particles were black and the background white.

The image was reversed (i.e. to produce white particles on a black background) and any particles in contact with the edge of the image (and therefore partly obscured) were deleted. The end result at this stage was a binary segmentation mask. These were also archived.

Prior to measurement, each image was put through an 'opening' procedure that alternately eroded and dilated particles three times. This had the effect of smoothing the surfaces slightly and removing small surface decorations which do not contribute to the overall shape or size of the object, but which can inflate an estimate of its perimeter. This part of the procedure was performed in the aforementioned KONTRON KS 300™ imager analyser.

Particles were then measured and the data aggregated from all the images in each sample set. The results obtained are given in Tables 8 below.

TABLE 4

Comparison of known and novel teas by measuring frequency of particles having certain D-circle perimeter ratios

SAMPLE	% DCPR < 1.2	% DCPR 1.2-1.39	% DCPR 1.4-1.59	% DCPR ≥ 1.6
ctc1	12.5	68.0	16.7	2.9
ctc3	25.0	61.9	9.5	3.7
ctc6	20.3	65.6	9.7	4.4
ctc8	12.4	66.0	19.5	2.1
ctc10	19.7	66.3	12.2	1.8
odx1	8.1	53.4	24.3	14.3
odx2	21.5	56.2	13.6	8.7
odx3	4.3	34.2	36.2	25.3
odx4	3.2	33.7	33.0	30.2
odx5	12.6	48.8	28.0	10.6
odx7	11.4	40.5	29.6	18.5
odx7	11.4	40.5	29.6	18.5

These results are presented as a frequency histogram in Figure 2.

The DCPR frequency histograms clearly shows differences between the different types of products. The CTC teas show a much higher proportion of particles in the <1.2 DCPR class (10 - 25%) than in the ≥ 1.6 class (3 - 4%); i.e. they consisted in the main of low aspect ratio material. The orthodox teas were more variable. ODX2 was much like a CTC in character, whereas ODX3 & ODX4 showed

only 3 - 4% in the <1.20 DCPR class but 25% & 30% in the ≥ 1.6 class. But in general, as best seen in Figure 2d, known orthodox manufactured teas contain significantly more particles having a DCPR greater or equal to 1.6 than known CTC manufactured teas.

The black leaf teas of the present invention, once again prepared by the process described in United Kingdom patent application GB 0010315.0, showed a clear distinction between the large leaf and the medium leaf fractions: the large leaf fractions having 20 - 25% frequency, similar to the ODX 3 & 4 samples, and the medium leaf fractions showing frequencies of 12 - 14%, comparable to ODX 1, 5 and 7.

EXAMPLE 4

Differentiating between the infusion performance of orthodox and CTC teas by infusion performance

Orthodox manufactured teas generally infuse more slowly than CTC manufactured teas. This reflects the degree of maceration. One would therefore expect a black leaf tea that resembles orthodox tea will to infuse like an orthodox tea.

The inventors selected some of the 13 teas from around the world used in Examples 1 to 4 and compared the infusion performance of those teas against teas made by the process described in our co-pending United Kingdom patent application GB 0010315.0 (143 LL and 147 ML) and the process of the present invention (A269 ML and A270 ML). The teas were selected purely on the basis of comparable leaf sizes. This was necessary since small leaves have a larger surface to volume ratio than large leaves and thus will tend to infuse faster than large leaves anyway.
In each case 200 ml boiling deionised water was added to a pre-warmed Thermos flask containing 2 g (±0.05 g) leaf tea. The flask was stoppered and briefly inverted, then the leaf was allowed to

infuse for 3 minutes. The flask was then inverted again, and the liquor filtered through WHATMAN 541™ filter paper, using a Buchner funnel and flask under vacuum.

The colour of the infusions was measured on a HUNTERLAB ULTRASCAN Xe™ colorimeter using a standard analytical method (provided by the manufacturer). The results quoted in Table 9 below are for a 1 cm path length, with D65 illuminant and an observer angle of 10°.

TABLE 9

Infusion performance of leaf teas of comparable size

SAMPLE	L*	a*	b*
ODX01	83.1	8.5	69.7
ODX02	81.9	8.3	61.2
ODX05	82.2	11.2	79.9
ODX06	82.5	9.3	74.2
ODX07	79.1	11.9	72.5
CTC01	80.8	12.8	82.8
CTC02	79.7	13.5	80.7
CTC03	77.9	19.1	91.9
CTC04	80.4	12.5	80.4
CTC07	77.3	12.0	75.3
CTC08	75.4	14.7	80.4
CTC09	74.3	17.5	85.3
CTC10	-	18.7	91.2
143 ML	80.45	14.12	82.92
147 ML	78.55	16.9	86.95
A269 ML	79.47	16.28	91.50
A270 ML	80.72	14.56	89.09

The a* and b* values were plotted to give Figure 1. Each point on the graph plots the position of the liquor colour in colour space. Points nearer the top right hand corner of the graph represent liquors with stronger yellow or red components respectively.

On can see from Figure 1 that the leaf teas of the present invention (A269ML and A270ML) fall within the cluster of results for CTC teas rather than the cluster of results of the orthodox

teas. This clearly demonstrates that the black leaf teas of the present invention infuse like CTC manufactured teas rather than orthodox manufactured teas.

EXAMPLE 5

Differentiating between the infusion performance of orthodox and CTC teas by infusion performance in the absence of milk

The inventors infused each of the 17 teas from around the world used in Examples 1 to 4 and compared the infusion performance of those teas against teas made by the process described in our co-pending United Kingdom patent application GB 0010315.0 (143,146,147,149,152 LL and 143,146,147,149,152 ML) and the process of the present invention (280,281 ML and 280,281 LL).

In each case, to imitate the preparation of tea in Continental Europe, 2.0 g (±0.05 g) tea was infused in 250 ml of freshly boiled tap water (Crawley, United Kingdom) for 1.5 minutes and an expert tea taster assessed the liquor quality with respect to quality, colour, brightness and thickness.

Liquor quality was measured on a scale of from 0.6 to 9.4 as given in Table 10 below.

Table 10

Liquor quality assessment

Q - Quality	0.6 (plain)	9.4 (flavoury)
C - Colour	0.6 (yellow)	9.4 (red)
B - Brightness	0.6 (dull)	9.4 (bright)
T - Thickness	0.6 (thin)	9.4 (thick)

The results are given in Table 11 below.

TABLE 11

Liquor quality assessment of non-milked infusions

SAMPLE	Q	C	B	T
ODX1	4.0	3.0	4.2	3.0
ODX2	2.6	2.6	2.8	2.6
ODX3	4.4	2.2	4.0	4.0
ODX4	4.0	4.4	4.4	4.6
ODX5	5.2	2.2	5.4	3.0
ODX6	4.6	2.0	5.6	2.6
ODX7	4.4	3.0	5.2	4.0
CTC1	5.0	4.0	6.0	3.6
CTC2	3.0	4.2	5.0	3.4
CTC3	4.0	4.2	5.0	2.2
CTC4	3.4	4.6	5.0	3.0
CTC5	2.8	4.4	4.6	3.6
CTC6	2.6	3.2	4.0	3.0
CTC7	5.6	2.0	6.0	2.8
CTC8	4.6	4.6	5.8	4.6
CTC9	3.6	4.4	5.6	4.0
CTC10	4.8	4.0	5.8	5.0
143 LL	5.0	3.8	5.2	4.0
146 LL	4.6	4.2	5.2	4.2
147 LL	5.2	4.0	5.4	4.0
149 LL	5.0	4.2	5.2	4.2
152 LL	5.4	3.6	5.4	4.0
143 ML	4.8	4.4	5.2	4.4
146 ML	4.4	4.8	5.4	4.6
147 ML	4.6	4.4	5.4	4.4
149 ML	4.8	4.4	5.4	4.4
152 ML	5.0	4.0	5.4	4.0
280 LL	5.0	4.0	5.0	4.2
281 LL	5.2	4.0	5.0	4.0
280 ML	5.0	4.4	5.0	4.4
281 ML	5.2	4.4	5.0	4.6

The Q (quality) and C (colour) values were plotted to give Figure 2. One can see from that Figure that the known CTC manufactured teas tended to provide more colourful infusions than the known orthodox manufactured teas. It is also clear from Figure 2 that black teas of the present invention infuse in manner akin to the more colourful CTC manufactured teas rather than orthodox manufactured teas.

EXAMPLE 6

Differentiating between the infusion performance of orthodox and CTC teas by infusion performance in the presence of milk

The inventors infused each of the 17 teas from around the world used in Examples 1 to 4 and compared the infusion performance of those teas against teas made by the process described in our co-pending United Kingdom patent application GB 0010315.0 (143,146,147,149,152 LL and 143,146,147,149,152 ML) and the process of the present invention (280,281 ML and 280,281 LL). In each case, to imitate the preparation of tea in the United Kingdom, 3.125 g (±0.05 g) tea was infused in 235 ml of freshly boiled tap water (Crawley, UK) and an expert tea taster assessed the liquor quality with respect to quality, colour, brightness and thickness. Liquor quality was measured on a scale of from 0.6 to 9.4 as given in Table 10 above. The results are given in Table 12 below.

TABLE 12

Liquor quality assessment of milked infusions

SAMPLE	Q	C	B	T
ODX1	4.2	3.2	4.4	3.6
ODX2	2.4	2.0	2.0	2.6
ODX3	4.2	2.6	4.6	3.8
ODX4	3.8	2.8	4.0	4.6
ODX5	5.6	3.6	5.8	3.2
ODX6	4.4	3.2	5.4	3.0
ODX7	4.0	2.8	4.6	4.0
CTC1	4.6	4.0	6.0	3.6
CTC2	2.8	4.2	4.4	3.0
CTC3	3.8	6.6	4.2	2.2
CTC4	3.2	5.0	4.0	2.8
CTC5	2.8	4.2	4.4	3.8
CTC6	3.0	5.8	4.0	3.0
CTC7	5.6	4.0	6.4	3.0
CTC8	3.6	7.2	3.6	4.2
CTC9	4.0	4.0	5.0	4.0
CTC10	4.6	4.0	6.0	4.6
143 LL	4.6	5.6	4.0	4.0

146 LL	4.2	5.6	4.2	4.0
147 LL	5.0	5.2	4.8	4.2
149 LL	4.6	5.4	4.4	4.0
152 LL	5.2	5.0	5.0	4.2
143 ML	4.4	5.8	4.0	4.4
146 ML	4.2	6.0	4.0	4.4
147 ML	4.6	5.6	4.4	4.4
149 ML	4.4	5.8	4.2	4.6
152 ML	5.0	5.0	5.0	4.2
280 LL	4.8	4.4	5	4.4
281 LL	5.2	4.6	5	4.4
280 ML	5	4.8	5.2	4.6
281 ML	5.2	4.8	5.2	4.8

The Q (quality) and C (colour) values were plotted to give Figure 3. One can see from that Figure that all of the known CTC manufactured teas provided more colourful milked infusions than all of the known orthodox manufactured teas. It is also clear from Figure 9 that black teas of the present invention provided milked infusions amongst the best of the known CTC manufactured teas.

CLAIMS

1. A process for manufacturing black tea comprising the steps of withering and macerating tea leaves, allowing them to ferment, firing the leaves to arrest fermentation and then drying them to yield black leaf tea,

   the process being characterised in that the tea leaves are withered to a moisture content of between 64 and 68% and macerated by the controlled application of both shear and compression forces.

2. A process according to claim 1 wherein the withered tea leaves are passed through a rotorvane machine and a CTC machine to macerate them.

3. A process according to claim 2 wherein the blade of the CTC machine has 2 to 6 teeth per inch.

4. A process according to claim 1 wherein the withered leaves are subjected to said shear and compression forces by being passed through a rotorvane machine having reverse facing vanes.

5. A process according to claim 1 wherein the withered leaves are subjected to said shear and compression forces by being passed through an extruder machine.

6. A process according to claim 1 wherein the macerated leaf is subsequently further cut and shaped.

7. A process for manufacturing black tea substantially as herein described with reference to the examples.

ABSTRACT

Black tea manufacture

A process for manufacturing a fast infusing larger leaf black tea. The process involves withering tea leaves to a moisture content between 64 and 68%, macerating the withered leaves tea leaves by the controlled application of both shear and compression forces, allowing them to ferment, firing the leaves to arrest fermentation and then drying them to yield black leaf tea.

FIGURE 1

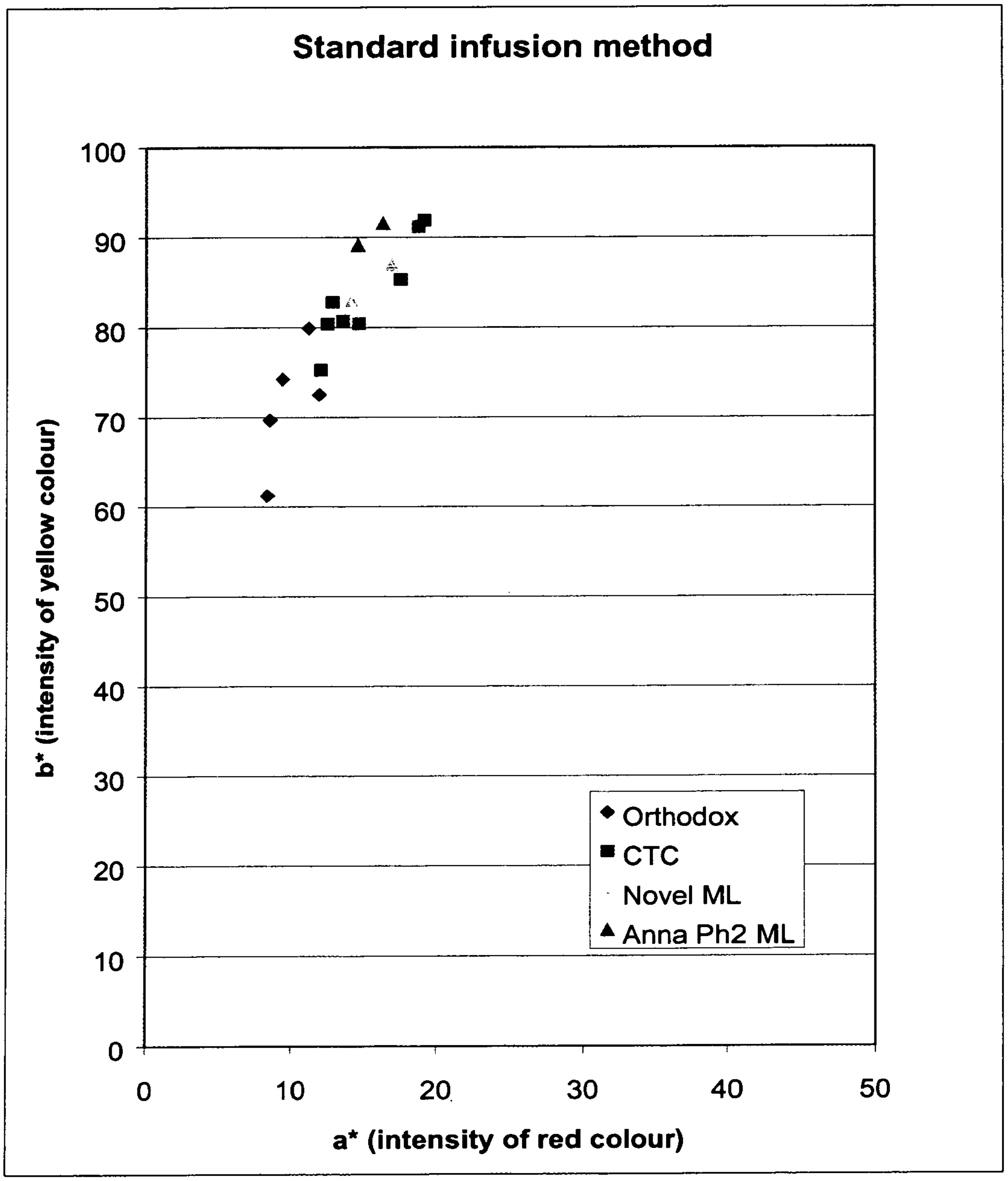

Standard infusion method
b* (intensity of yellow colour)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
a* (intensity of red colour)
Orthodox
CTC
Novel ML
Anna Ph2 ML

FIGURE 2

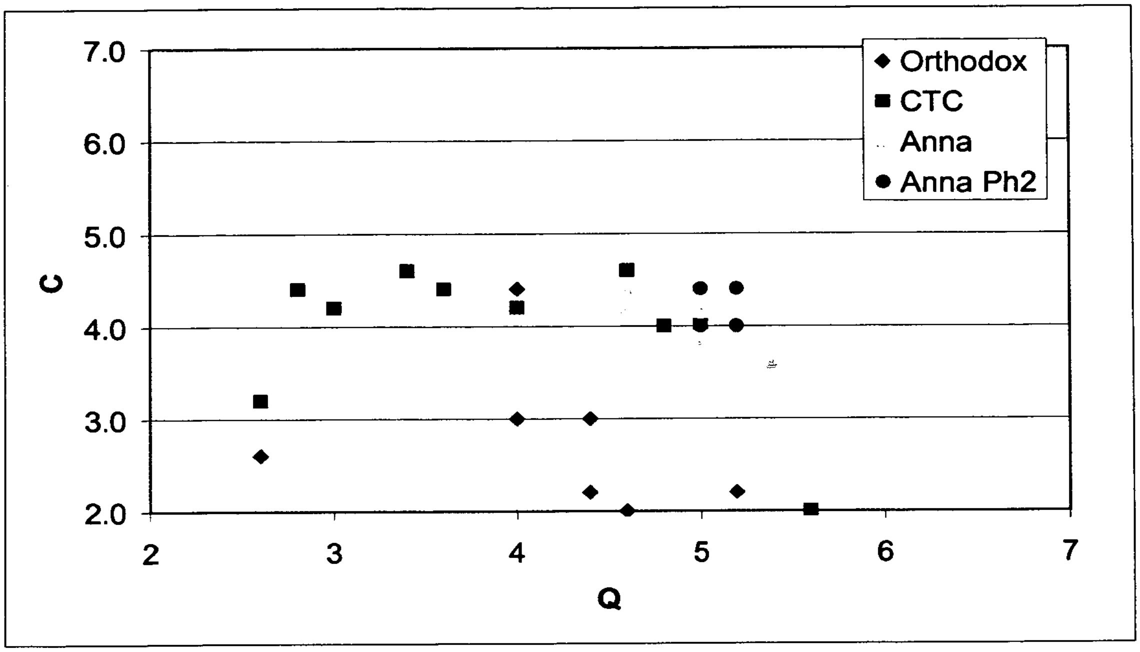


FIGURE 3

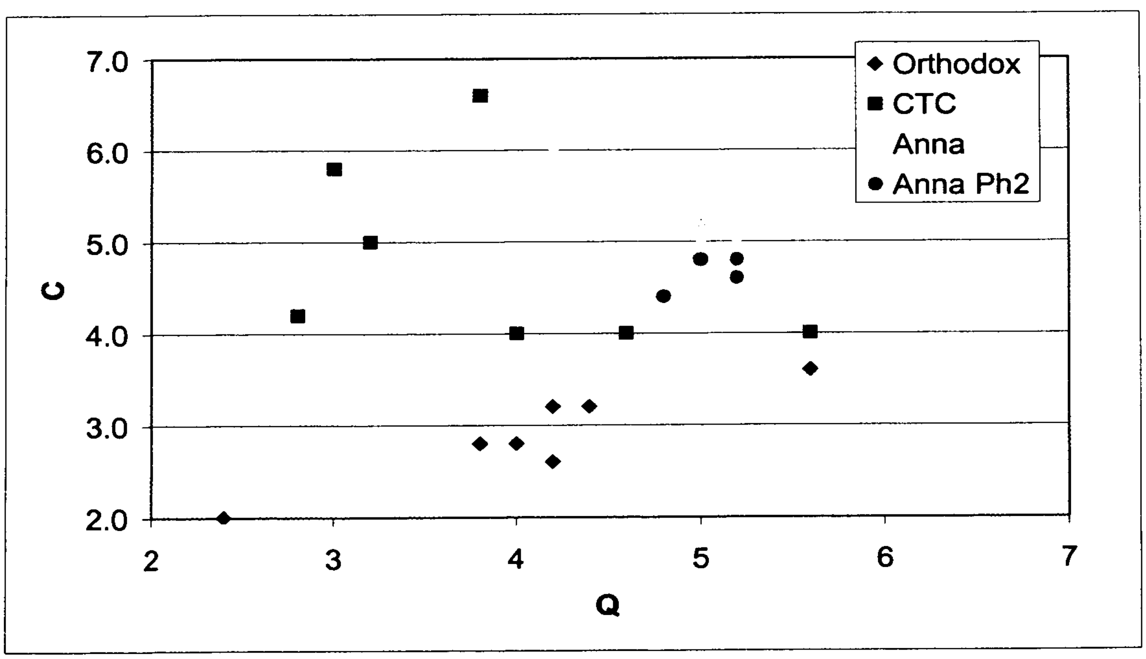


Figure 4

Simplified Process Schemes

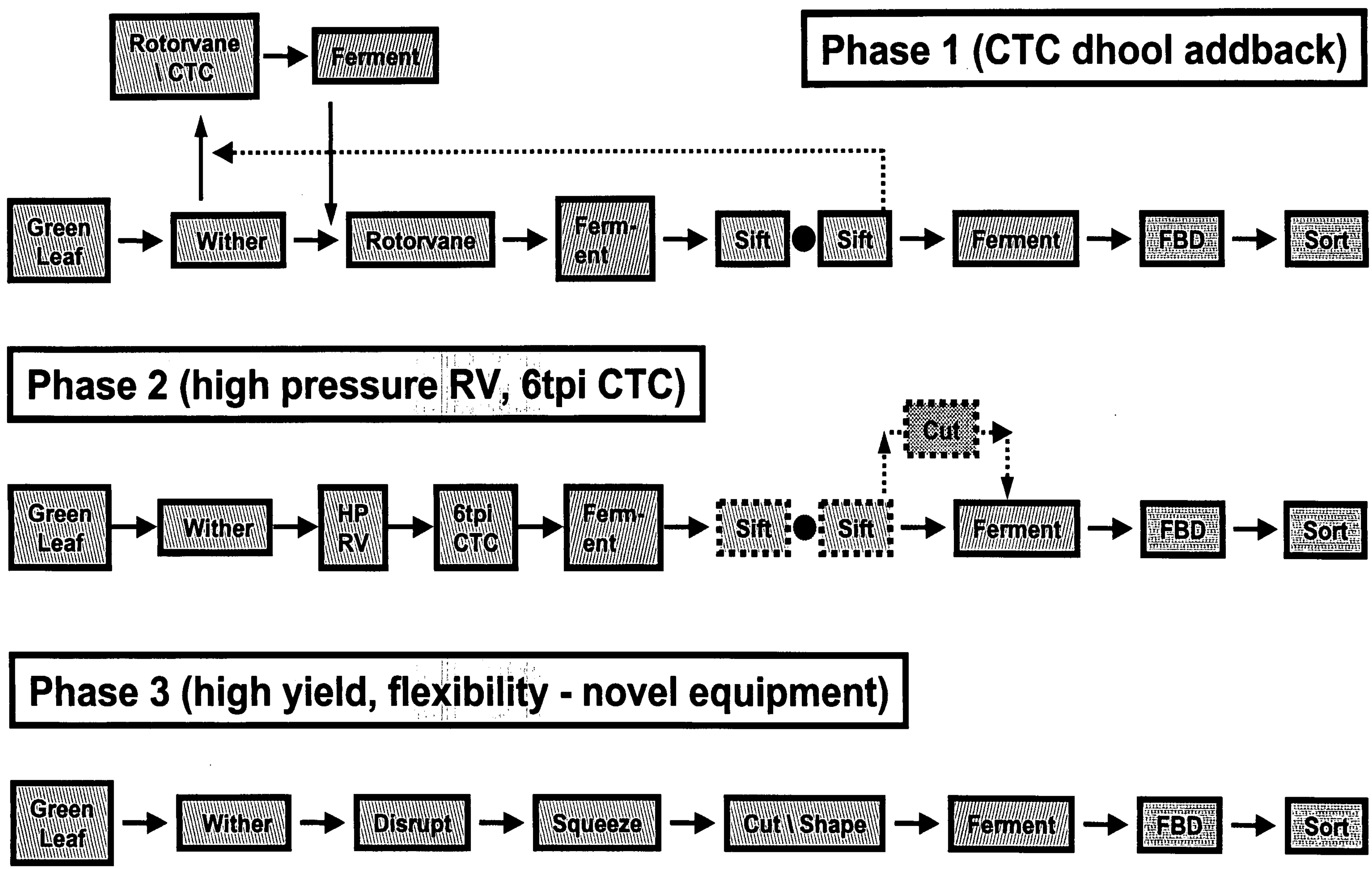


Figure 5

DCPR Quartile analysis - Phase 1, standard RV

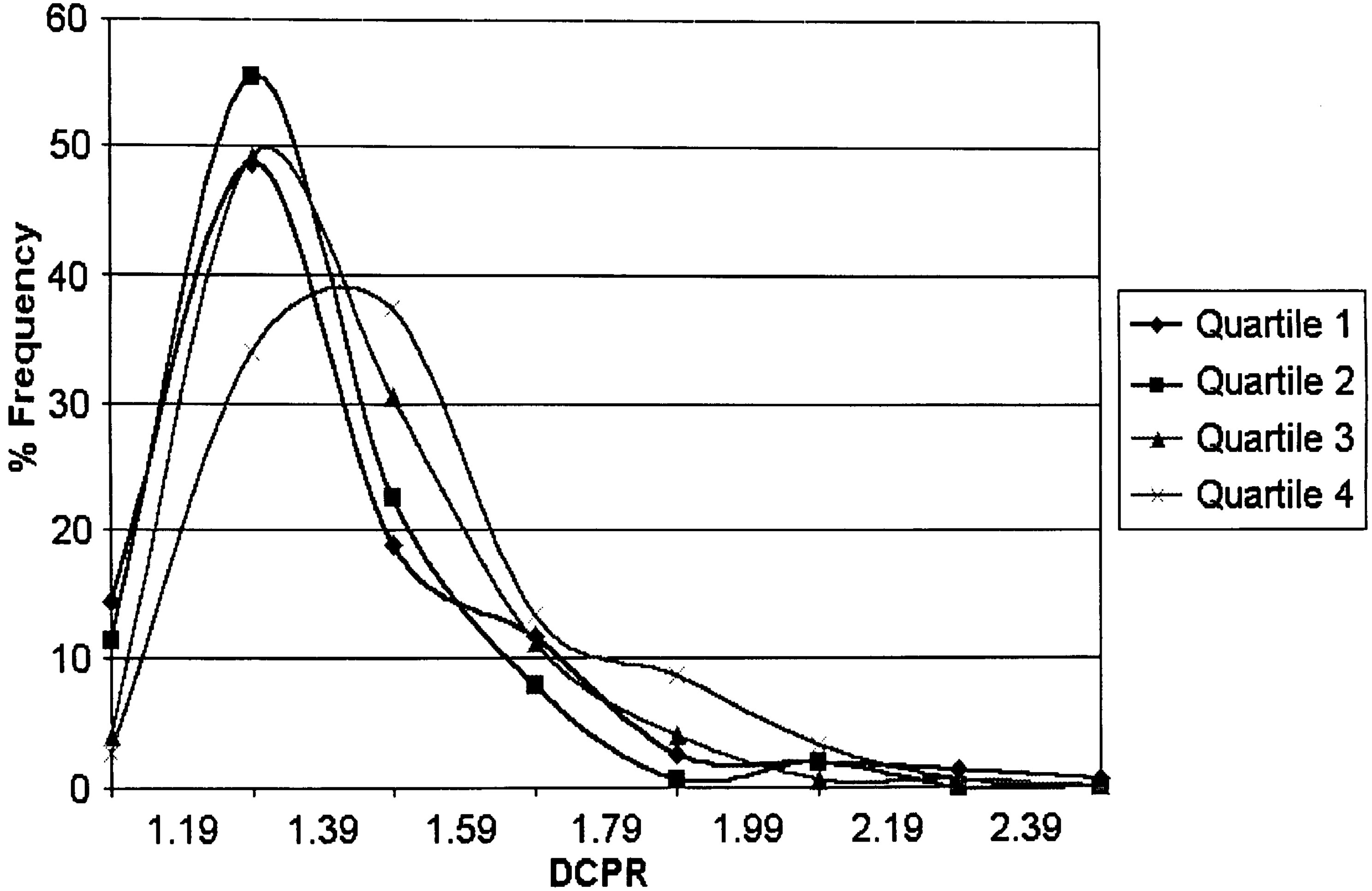


Figure 6

DCPR Quartile analysis - Phase 2, HPRV (no 6tpi)

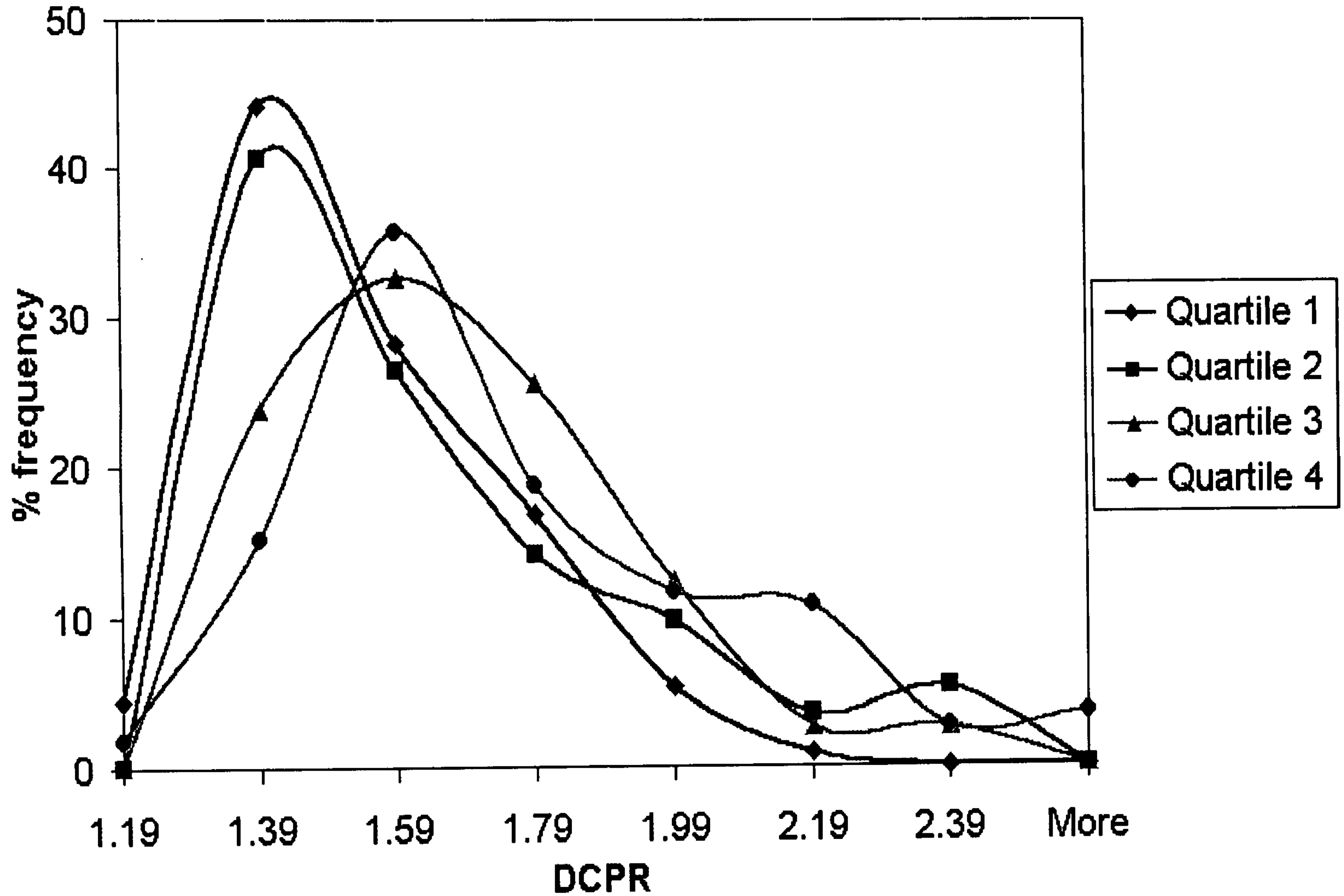


Figure 7

DCPR Quartile analysis - Phase 2, HPRV + 6tpi CTC

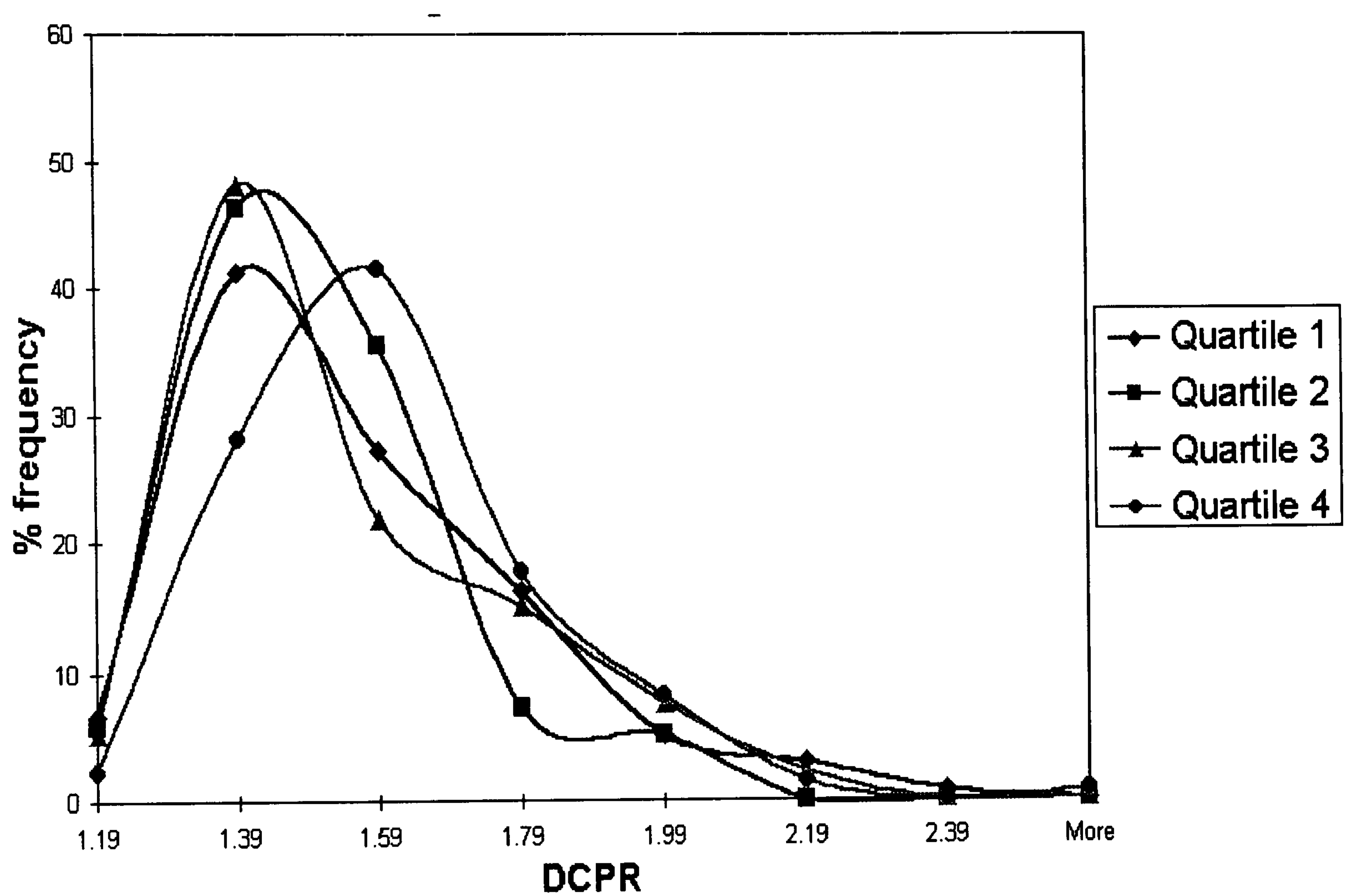


Figure 8

LL : Infusion Performance (unmilked) - Phase 1 vs Phase 2 (two replicate manufactures)

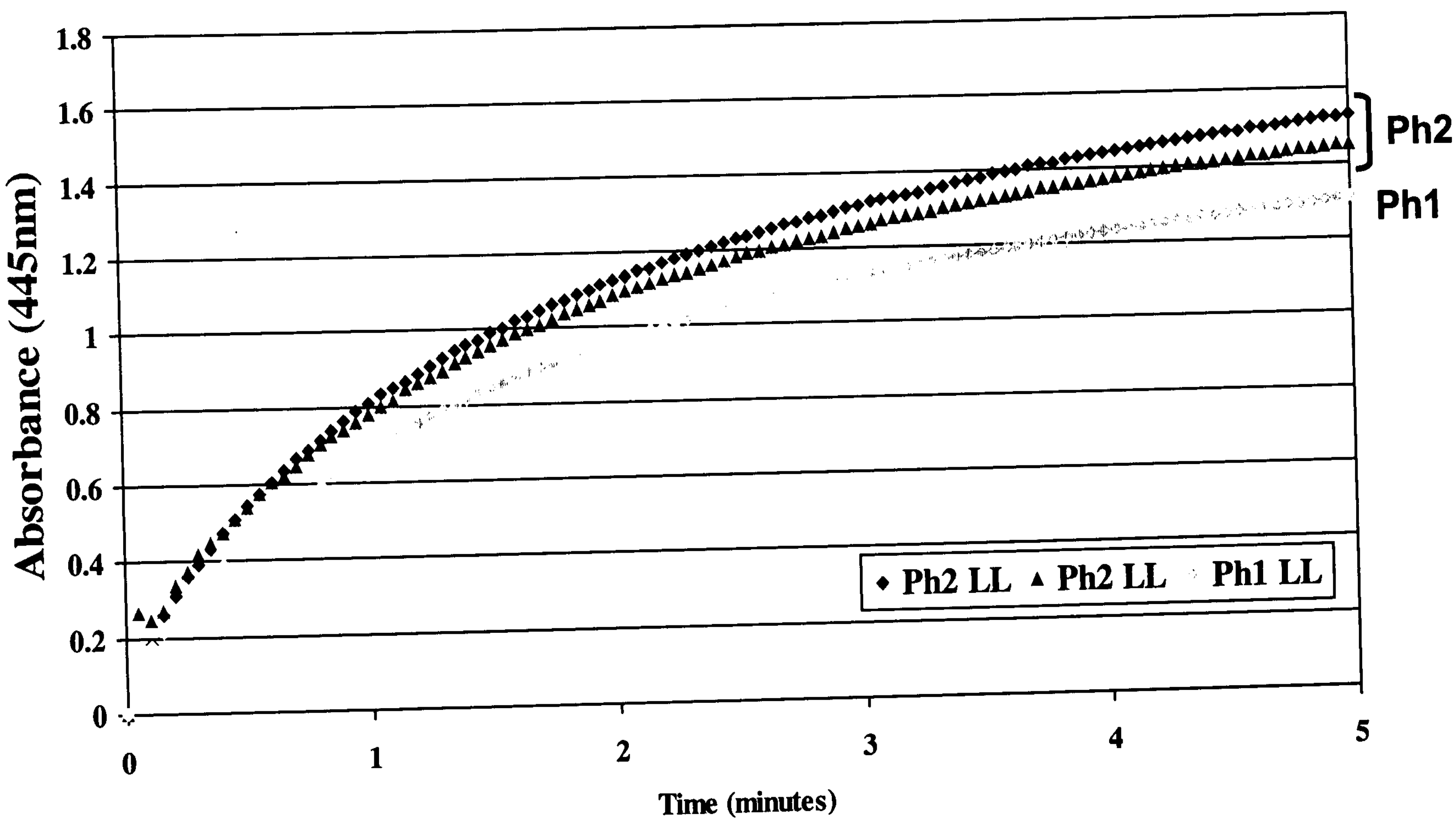


Figure 9

ML : Infusion Performance (unmilked) - Phase 1 vs Phase 2 (two replicate manufactures)

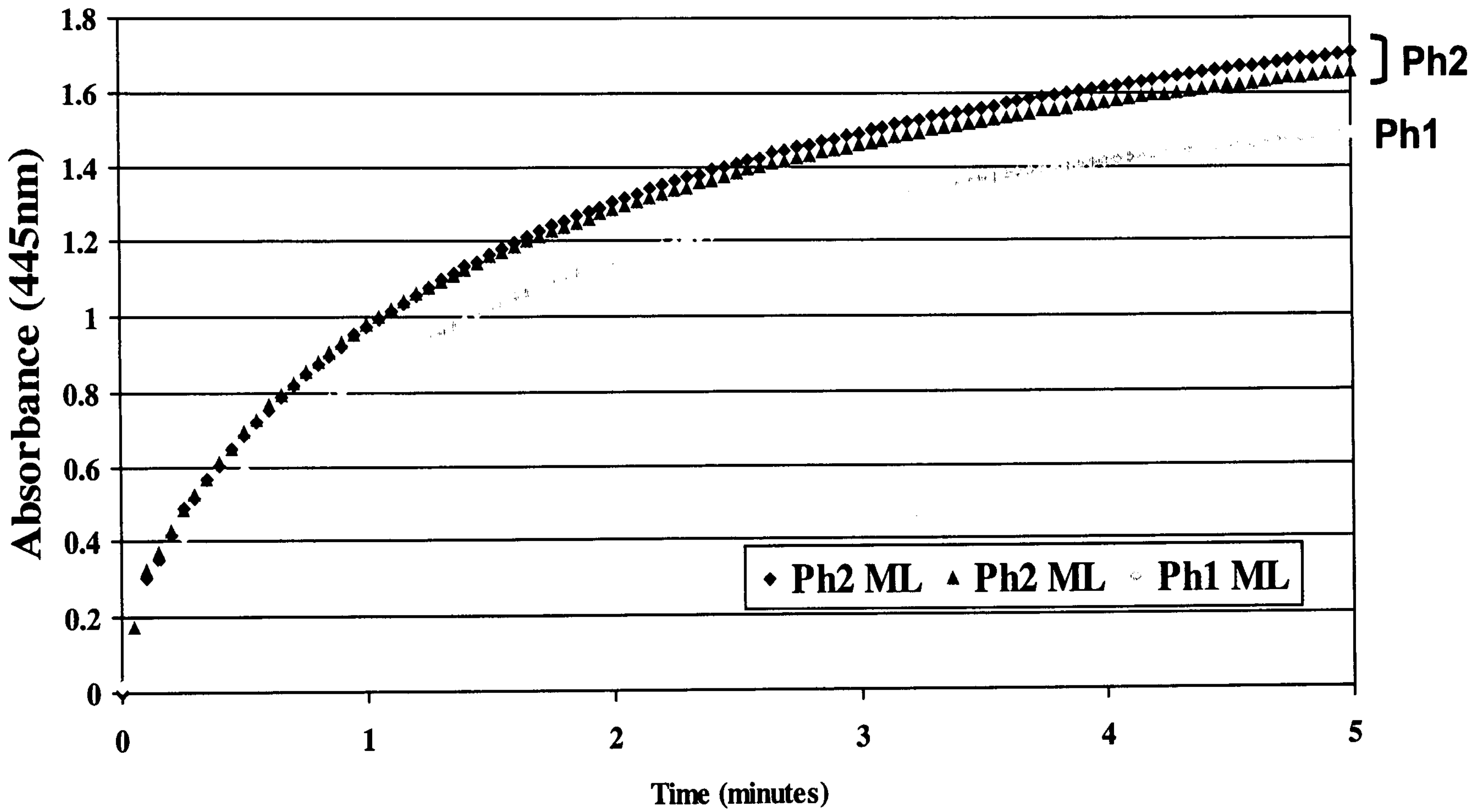
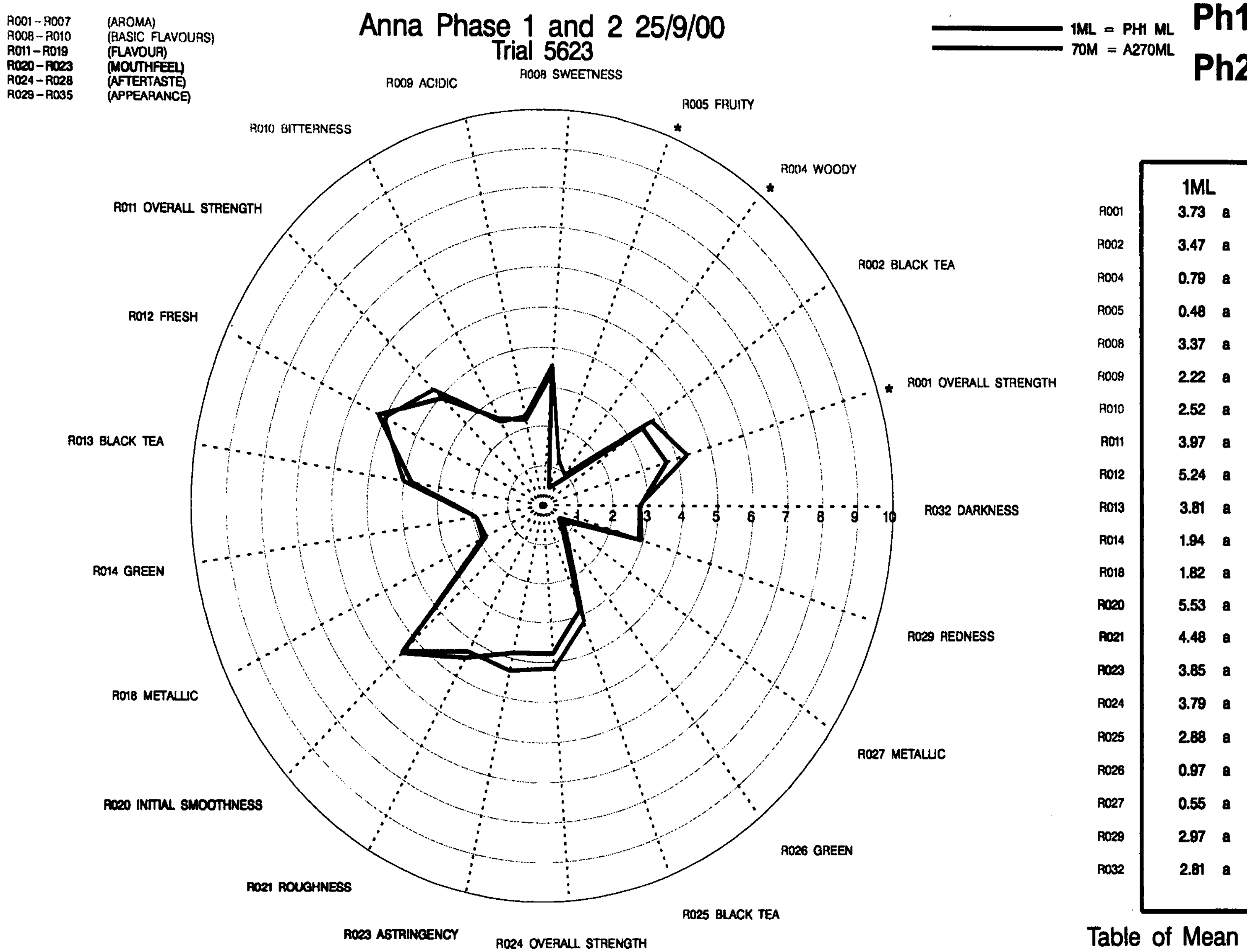


Figure 10

LL : Sensory Profile (unmilked) - Phase 1 vs Phase 2
(* = significantly different)

Anna Phase 1 and 2 25/9/00
Trial 5623



KEY: * Plotted treatments differ significantly (P<.05) by t-test

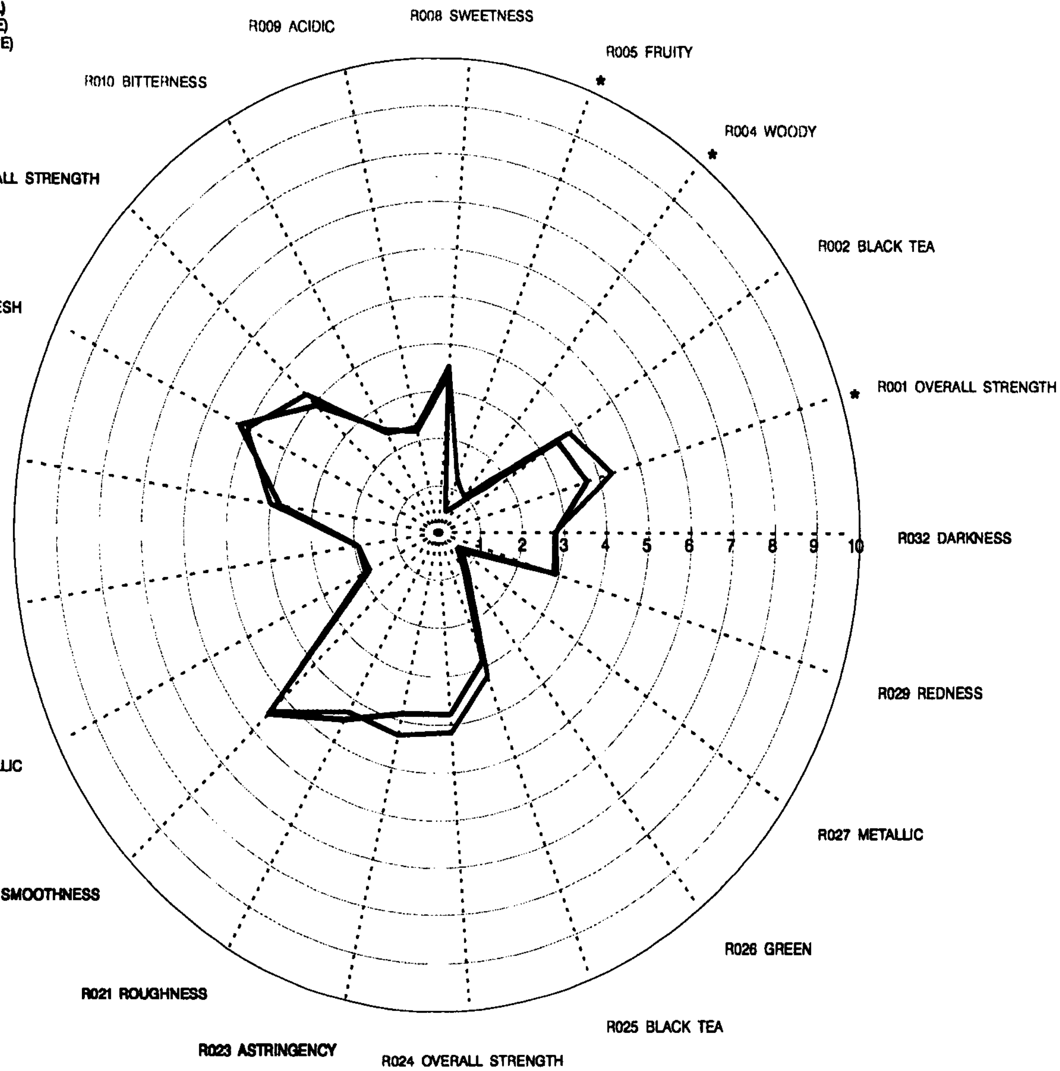
	1ML		70M	
R001	3.73	a	4.36	b
R002	3.47	a	3.79	a
R004	0.79	a	0.99	b
R005	0.48	a	1.24	b
R008	3.37	a	3.57	a
R009	2.22	a	2.30	a
R010	2.52	a	2.43	a
R011	3.97	a	4.29	a
R012	5.24	a	5.06	a
R013	3.81	a	4.05	a
R014	1.94	a	1.94	a
R018	1.82	a	1.93	a
R020	5.53	a	5.47	a
R021	4.48	a	4.30	a
R023	3.85	a	4.31	a
R024	3.79	a	4.16	a
R025	2.88	a	3.20	a
R026	0.97	a	1.15	a
R027	0.55	a	0.69	a
R029	2.97	a	2.89	a
R032	2.81	a	2.78	a

Table of Mean Panel Scores
also showing Multiple Comparisons

Figure II

ML : Sensory Profile (unmilked) - Phase 1 vs Phase 2
(* = significantly different)

R001 - R007	(AROMA)
R008 - R010	(BASIC FLAVOURS)
R011 - R019	(FLAVOUR)
R020 - R023	(MOUTHFEEL)
R024 - R028	(AFTERTASTE)
R029 - R035	(APPEARANCE)



KEY: * Plotted treatments differ significantly (P<.05) by t-test

	1ML		70M	
R001	3.73	a	4.36	b
R002	3.47	a	3.79	a
R004	0.79	a	0.99	b
R005	0.48	a	1.24	b
R008	3.37	a	3.57	a
R009	2.22	a	2.30	a
R010	2.52	a	2.43	a
R011	3.97	a	4.29	a
R012	5.24	a	5.06	a
R013	3.81	a	4.05	a
R014	1.94	a	1.94	a
R018	1.82	a	1.93	a
R020	5.53	a	5.47	a
R021	4.48	a	4.30	a
R023	3.85	a	4.31	a
R024	3.79	a	4.16	a
R025	2.88	a	3.20	a
R026	0.97	a	1.15	a
R027	0.55	a	0.69	a
R029	2.97	a	2.89	a
R032	2.81	a	2.78	a

Table of Mean Panel Scores
also showing Multiple Comparisons